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Conquering the Iron Mountain: Reducing the Marine Expeditionary Unit's Logistics Footprint Within the Amphibious Readiness Group

29 November 2011

by

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CONQUERING THE IRON MOUNTAIN: REDUCING THE MARINE EXPEDITIONARY UNIT'S LOGISTICS FOOTPRINT WITHIN THE AMPHIBIOUS READINESS GROUP

ABSTRACT

The Marine Corps–Navy team employs a concept of forward power projection under the Marine Expeditionary Unit (MEU). The MEU is built around a reinforced infantry battalion and an attached aviation element. The logistical unit of the MEU is the Combat Logistic Battalion (CLB). The CLB is tasked with embarking with 15 days of supply (DOS) to support the entire MEU should it be tasked into an austere environment for actions across a range of military operations (ROMO). Over the course of this sustainment concept, the Marine Corps has developed logistics habits, often dubbed the "Iron Mountain," that have led to each CLB on each MEU embarking with as much materiel as possible in order to meet the deployed maintenance needs. This process has led to great waste and an unnecessarily large materiel footprint, both aboard U.S. Navy ships and on the ground. This project sought to create a method that can be used to create the sustainment block more efficiently and in far less time using historical usage data and better information about resupply lead times, criticality, and demand. These data were analyzed using a multi-attribute decision-making tool to weigh all factors. This analysis verified that it is possible to craft a better source of sustainment.

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LIST OF ACRONYMS AND ABBREVIATIONS

AAC	Activity Address Code
AAV	Amphibious Assault Vehicle
ACWT	Average Customer Wait Time
AHP	Analytical Hierarchy Process
ARG	Amphibious Readiness Group
BLT	Battalion Landing Team
CE	Command Element
CEC	Combat Essentiality Code
CIF	Consolidated Issue Facility
CLB	Combat Logistics Battalion
CONUS	Continental United Sates
CSSE	Combat Service Support Element
DEA	Data Envelopment Analysis
DMU	Decision-Making Units
DOS	Days of Supply
EBA	Elimination-by-Aspects
EDL	Equipment Density Listing
GABF	General Account Balance File
GCSS-MC	Global Combat Support System-Marine Corps
GenPac	Generator Package
GUI	Graphic User Interface
HADR	Humanitarian Assistance and Disaster Relief
HAZMAT	Hazardous Material
HQMC	Headquarters, Marine Corps
MAGTF	Marine Air-Ground Task Force
MCCSSS	Marine Corps Combat Service Support School
MEF	Marine Expeditionary Force
MEU	Marine Expeditionary Unit
MHE	Material Handling Equipment

NCA	National Command Authority
NLI	Naval Logistics Integration
NMC	Non-Mission Capable
NMCS	Non-Mission Capable Supply
NPS	Naval Postgraduate School
NSN	National Stock Number
OCONUS	Outside the Contiguous United States
OEF	Operation Enduring Freedom
PALCON	Pallet Container
PEI	Principle End Item
POL	Petroleum, Oil, and Lubricants
QUADCON	Quadruple Container
ROMO	Range of Military Operations
SASSY	Supported Activities Supply System
SECREP	Secondary Repairable
SMU	SASSY Management Unit
SOP	Standard Operating Procedure
T/O	Table of Organization
USMC	United States Marine Corps

I. INTRODUCTION

Expeditionary logistics is a careful balancing act; without proper planning, a unit runs the risk of not deploying with the right amount of support—or worse, deploying with the wrong kind of support. This balancing act holds especially true for the United States Marine Corps (USMC), given the nature of USMC expeditionary operations throughout the world. The sustainment block of consumable Class IX supply items carried by the Marine Expeditionary Unit (MEU) Combat Logistics Battalion (CLB) is a specific example in which careful planning is crucial.

The CLB is tasked with embarking 15 days of supply (DOS) to support the entire MEU should it be tasked into an austere environment for actions across a range of military operations (ROMO). A critical issue with these sustainment blocks is that they have grown too large in size due to the Marine Corps' lack of focus concerning the fundamental purpose of the block itself. Originally, the concept behind the block was to support the MEU for 15 days should it be tasked by the National Command Authority (NCA) to conduct operations separate from an established supply pipeline prior to the arrival of follow-on forces. The current generally accepted employment of the sustainment block still holds this 15-day requirement, but it also allows for usage of the sustainment block for underway maintenance requirements.

Naval Logistics Integration (NLI) is a joint initiative sponsored by the Navy, Marine Corps, and Coast Guard to "provide common tactics, techniques, and procedures for leveraging NLI sanctioned initiatives in support of Naval expeditionary forces" (Office of Chief of Naval Operations Logistics Operations and Policy [OPNAV N41] & Headquarters, U.S. Marine Corps Logistics Plans, Policies, and Strategic Mobility [USMC LP], 2008, p. 1). The Marine staff that focuses on the NLI initiatives is located within the Logistics Vision & Strategy Branch, Logistics Plans, Policies, Strategic Mobility Division, Headquarters, Marine Corps Installation and Logistics Department. The Marine NLI staff is working toward the NLI mission end state, which is defined as:

> An integrated naval logistics capability that can operate seamlessly afloat or ashore, successfully supporting and sustaining operating units in a joint warfighting environment. NLI outcomes and benefits include: improved logistics responsiveness and agility, improved and sustained combat support readiness, reduced logistics workload both afloat and ashore, recapitalized funding of naval logistics processes for more efficient use of resources. (Deputy Commandant, Installations and Logistics [DC I&L] Headquarters, Marine Corps, Deputy Chief of Naval Operations for Fleet Readiness and Logistics [DCNO N4], and Chief of Staff [CG-01] Headquarters, Coast Guard, 2007, p. 4)

One such initiative is an effort to improve efficiencies of the MEU sustainment block to a sufficient degree so that each CLB supply officer does not have to reinvent the wheel by crafting a unique sustainment block prior to each deployment in order to reduce the overall cost and materiel footprint.

A. TERMS AND DEFINITIONS

The term *sustainment block* encompasses a variety of supply items under different classes of supply. Within the sustainment block that each CLB is tasked with building and deploying, there are three classes of supply that are broken down into six separate and distinct blocks. The three classes of supply within every CLB sustainment block are as follows: Class II, organizational equipment and supplies; Class III, petroleum, oil, and lubricants (POL); and Class IX, repair parts.

Class II, as defined by the Marine Corps, is "organizational equipment and supplies consisting of clothing, individual equipment, tentage, organizational tool sets, tool kits, handbooks, and administrative and housekeeping supplies and equipment" (Marine Corps Combat Service Support School [MCCSSS], n.d., p. 3). The block consisting of Class II items is referred to as the Consolidated Issue Facility (CIF) block because the majority of this block is received from the CIF located on each major Marine Corps installation. The CLB draws a block from the CIF that has quantities equal to roughly 10% of the requirement for the Marines and Sailors on the MEU's Table of Organization (T/O). The CIF block carried by the CLB is to act as a source of safety

stock to resupply individual needs since each Marine and Sailor draws his or her own CIF supplies independently.

Class III, as defined by the Marine Corps, is "petroleum, fuels lubricants, hydraulic and insulating compressed gasses, bulk chemical products coolants, de-icing and antifreeze compounds, together with components and additives of such products, also coal" (MCCSSS, n.d., p. 3). This block is referred to as the POL block; there is a current NLI initiative in place to reduce the size of this block by allowing MEU units to access POLs already on board the amphibious ready group (ARG) ships.

The last class of supply within the sustainment block is Class IX, which is broken into four smaller categories. These four categories are batteries, tires, secondary repairable (SECREP) maintenance items, and consumable maintenance items. Class IX repair parts, as defined by the Marine Corps, are "all repair parts and components, including kits, assemblies, and subassemblies (reparable and non-repairable) required for maintenance support of all equipment" (MMCCSSS, n.d., p. 4). The Marine Corps defines SECREPs as "major components to end items that are repairable by appropriate maintenance technicians" (MCCSSS, 2004, p. 13). In this project, we focused solely on Class IX consumable repair parts because this class is the largest segment of the MEU sustainment block.

B. THE PROBLEM

The original purpose behind the MEU sustainment block was to support the MEU for 15 days ashore once tasked by the NCA. Under this concept, the sustainment block should be stocked with all necessary items required to keep all principle end items (PEI) combat effective. Also, under this mentality, the sustainment block should be used only once ashore, so the majority of its parts should be items that are critical to the functioning of PEIs and that have longer lead-times through normal supply pipelines.

Over time, however, the established use of the sustainment block has changed. Today it is considered acceptable, and even necessary, to utilize the block as a source of supply while underway. The main reason for the change in sustainment block usage is

that MEUs have deemed the sustainment block as the first source of supply when conducting both preventative and corrective maintenance on MEU assets while underway. The goal of this maintenance is to keep all PEIs combat ready should the NCA task the MEU. When the sustainment block is used as the first source of supply, commanders do not want to wait for the normal supply channels to deliver the necessary repair parts if the parts are present in the sustainment block. This practice also leads to each MEU CLB embarking with more materiel in order to meet the perceived need for maintenance consumables. It is our position that this shift in usage results in an unnecessarily large footprint aboard Navy amphibious ships, wasted supply funds, and an excess of man-hours required to order, pack, deploy, and manage the larger sustainment block.

C. CURRENT BLOCK CONSTRUCTION

As it stands currently, there are no Headquarters, Marine Corps–approved standardized procedures or metrics for building an MEU sustainment block. Currently, each Supported Activities Supply System (SASSY) Management Unit (SMU) and MEU has a slightly different approach when it comes to preparing the initial list, referred to as a generator package (GenPac), of all consumable repair parts that could be included in the sustainment block. This GenPac is evaluated and pared down in a variety of ways by each SMU before finally being given to the CLB supply officer.

After the GenPac is handed over to the CLB supply officer, it is then pared down even further. Each supply officer can edit the GenPac as he or she sees fit in order to arrive at the final list of national stock numbers (NSNs) that the MEU will carry within the sustainment block. This process is unique to each supply officer and done prior to each deployment. During his or her coordination with the SMU, each supply officer has sole control over how to use the historical data in creating the sustainment block. This methodology can lead to ad hoc decision-making with regard to almost any aspect of the block, including the stocking levels of individual items.

This form of block construction results in the "Iron Mountain" and a bring-everything-and-the-kitchen-sink mentality on the part of the CLB supply officer. This

mentality then leads to an unnecessarily large materiel footprint onboard Navy amphibious ships, which can then result in fouled flight spots on the flight decks and reduced operational capacity.

D. AN ALTERNATE SOLUTION

In this project, we developed an alternate model for determining what consumable repair parts should be included in the MEU sustainment block. The purpose of this model is to reduce the amount of waste—in time, space, and money—that goes into constructing the sustainment block for an MEU deployment. To construct the model, we chose Tversky's (1972) elimination-by-aspects (EBA) model as the best method to use in order to go from the GenPac to a useable sustainment block that could be brought on deployment. We review the background of the EBA model in Chapter II and how we employed it in GenPac creation in Chapter IV.

One of our goals for this project was to develop an improved method of creating the MEU sustainment block by using relevant historical data. As part of this goal, we utilized Class IX usage data from previous MEU deployments and from Marine Corps units currently deployed in support of Operation Enduring Freedom (OEF). We used data from OEF units in order to take into account the actual usage of Class IX repairables in a kinetic environment. All of the Class IX data are freely available through Marine Corps information systems; however, the data are not currently used to create sustainment blocks in the way we used them in this project. After creating an example GenPac using the EBA model, we then compared our sustainment block to previously employed sustainment blocks to determine the differences and whether our sustainment block had measurable advantages in efficiency and readiness.

In order to create a method for preparing the sustainment block, we employed the EBA method of decision-making. This method allowed us to narrow the list of possible NSNs that could be included in the sustainment block from the GenPac to a cohesive list based on the various parameters of the historical requisition data. These parameters included the combat essentiality code (CEC), average customer wait time (ACWT), hits, and total demand for each possible NSN across all MEUs.

One of the recommendations we make in the final chapter of this thesis concerns the manner in which MEU requisition data are collected and retained. Currently, the MEUs do not utilize historical MEU requisition data when constructing their sustainment block prior to a deployment. One of our goals for this project was to demonstrate the value in retaining and using historical MEU requisition data as part of the construction model we developed. Our model can be used once by a particular MEU and then reused in the MEU's next deployment cycle. This form of continual employment would lead to a lower number of man-hours being devoted solely to basic sustainment block construction. The time spent building a block from scratch could be better utilized for training or further tailoring an existing sustainment block for added gains in efficiency and readiness. Another benefit of our model is that it can be adapted to future equipment density lists (EDLs) and still produce useful results, meaning that it can still be employed when weapons systems and equipment are changed and upgraded, as will inevitably happen.

Our ultimate goal for this project was to increase efficiency and decrease the overall materiel footprint of the sustainment block while maintaining or increasing the current level of combat readiness of each MEU.

II. LITERATURE REVIEW

In order to formulate a standard method for creating the MEU sustainment block using historical requisition data, we needed to determine what past attempts had been made to improve the methods for creating a sustainment block. In June 1997, LT Laforteza of the Naval Postgraduate School (NPS) attempted to improve these methods in his master's thesis. In addition to researching past methods of improvement, it was also necessary for us to look at several possible methods of multi-criteria decision-making in order to determine the method that would best fit the project. We summarize the four methods that we considered in Section B.

A. MASTER'S THESIS

LT Laforteza (1997) wrote the only NPS master's thesis that has dealt with attempting to improve the method of creating the MEU sustainment block. The main issue in his thesis, *Inventory Optimization of Class IX Supply Blocks for Deploying U.S. Marine Corps Combat Service Support Elements,* was that "items requested by the Marine Air Ground Task Force (MAGTF) that the Combat Service Support Element (CSSE) doesn't carry, or doesn't have on-hand, must be ordered from a remote land-based supply point or a sea-based asset" (Laforteza, 1997, p. 6). LT Laforteza wrote that the binding constraint for this issue was the amount of space that the commanding office of the ship allowed. He then determined that the best area to focus on was determining the back-order time for each item within the MEU sustainment block and building a process to assign what he referred to as "mission priority factors" (Laforteza, 1997, p. 23) to each PEI to ensure that the MEU takes only the most important items.

In his model, LT Laforteza considered the following items: the total available volume, the demand, the dimensions of each item, the weight, the sustainment planning horizon (15 days of support for an MEU), and the mission priority factors. LT Laforteza stated, "Mission priority factors are intended to customize the supply block according to MAGTF missions" (Laforteza, 1997, p. 23). LT Laforteza proposed a priority matrix that

assigned a mission priority for each end item for a particular mission. He used the categories and weight factors of critical (1.0), very important (0.7), important (0.5), and desirable (0.4) to rank the Class IX parts according to the different MEU mission sets. The objective of his model was to provide the MEU with a decision aid for building the sustainment block while minimizing back orders in order to maximize equipment availability and readiness. LT Laforteza ran the model six times against actual usage requisitions from the 11th MEU's 1996 deployment.

Using the results from his model, LT Laforteza determined both the positive and negative differences between the actual 11th MEU Class IX demand and what the model recommended. During all runs of the model, the supply block that the model recommended would have led to fewer back orders in every mission priority category and in all combinations of data parameters. LT Laforteza's model had a secondary effect: If the MEU could reduce the number of back orders, then it could also reduce its shipping costs because the MEU would not be ordering as many items from continental United States (CONUS) locations and using premium transportation to receive those items. Using the best result from this model, LT Laforteza suggested that the 11th MEU could have saved over $11,000 in shipping costs.

B. METHODS OF MULTI-CRITERIA DECISION-MAKING

1. Goal Programming

Goal programming started as an extension of linear programming, but has since distinguished itself over the years as a unique problem-solving methodology (Schniederjans, 1995, p. 2). What distinguishes goal programming from linear programming is the number of objectives that the model can manage. Where linear programming models only manage a single objective, goal programming models can handle multiple, conflicting objective measures.

Usually referred to as constraints in linear programming, these constraints make up separate functions in goal programming, which are then viewed as individual goals or objectives. These multiple objectives are given a goal or target to be achieved, although

they can also be treated as constraints in the actual model, while unwanted deviations from the target values are minimized. The best solution comes from minimizing these deviations and coming as close as possible to the indicated goals (Schniederjans, 1995, p. 4).

The objective function of a goal programming model is a general statement of desire from the decision-maker for the model; examples include minimizing cost, reducing emissions, or maximizing profit. An aspiration level is a specific or acceptable value related to the stated objective that functions as a specific measure to allow for determining the level of achievement of the model itself. The goal is a specific objective centered on the aspiration level, such as earning at least $1,000 in profit or realizing 10% in inventory savings. Finally, deviation is the difference between the stated aspiration and what is actually achieved with the model.

2. Analytical Hierarchy Process

> The analytic hierarchy process is a flexible model that allows individuals or groups to shape ideas and define problems by making their own assumptions and deriving the desired solution from them. It also enables people to test the sensitivity of the solution, or outcome, to changes in information. (Saaty, 1990, p. 22)

In light of this quote from Thomas Saaty, the analytical hierarchy process (AHP) can best be thought of as a round-table process. It gathers the collected experiences, beliefs, perceptions, and judgments of participants in the decision-making process and then makes use of that information. When using an AHP, the decision-makers first break the problem up into a hierarchy of forces or elements. Then in the round-table portion, participants assign numerical weights to the different problem elements in order to compare and rank them against each other. Then, using these numbers, the participants prioritize the elements of the hierarchy. It is at this point that the decision-makers can come to a conclusion concerning the problem (Saaty, 1994).

An AHP formalizes a method of reaching a decision by assigning ranks to all parameters or elements of a decision when there may not have been an obvious way of doing so by using the collective experience and knowledge of all the participants in the

decision-making process. This method is an option for use in this project because, in the GenPac building process, it is not obvious which NSN parameters should be prioritized in order to achieve an optimal sustainment block. Using an AHP would allow for a formal process of ranking each parameter and then filling the block based on those parameters at the top of the hierarchy and working down. If used to its full potential, the AHP would take into account the various viewpoints on the data parameters and on the sustainment block itself that are always present in the MEU. An AHP would be largely focused on the viewpoint of the CLB supply officer, the maintenance community, and the PEI operators.

3. Data Envelopment Analysis

Data envelopment analysis (DEA) involves using a set of *peer entities*, referred to as decision-making units (DMUs), and evaluating their performance. DMUs are flexible and generic by intention so that DEA can be used in a variety of applications. According to Cooper, Seiford, and Zhu (2004), DEA is a "methodology directed to frontiers rather than central tendencies." Because of this, they argue that DEA can be used to highlight relationships that other decision-making methodologies fail to uncover.

DEA differs from some of the other methodologies that we considered using in this project because, with this method, inputs and outputs do not require any prior measures or weights of importance. Instead, DEA aims to show the relative efficiency of the DMUs related to the particular model by comparing them with the best possible outcome that can be achieved by those specific DMUs. When graphed, these "best possible outcomes" create a frontier of the best outcomes to the model. Then all actual DMUs are compared to this frontier; if any fall short of the frontier, those DMUs, or possibly producers, are determined to be inefficient. These inefficiencies stem from the realization that the actual DMUs should be able to achieve the same efficiencies as the best possible outcomes, given the same inputs and outputs as demonstrated on the DEA frontier.

A major limitation that affects DEA, and that would have had a significant impact on this project, is its computational intensiveness. Each DMU creates a separate linear

program, which for this project could have been potentially thousands of linear programs, since each NSN could be included in the GenPac and would be a DMU (Cooper, Seiford, & Zhu, 2004). Because of the need for a large amount of computational power, we opted for a different multi-criteria decision-making method.

4. Elimination-by-Aspects

As we stated in Chapter I, the EBA model is the multi-criteria decision-making process that we determined to be the best fit for this project. It allows for all aspects of historical requisition data to be taken into consideration when determining what NSNs to include in the GenPac without needing specialized software or significant computing power beyond Microsoft Excel and standard-issue laptops. The EBA model also allows for flexibility in prioritizing what aspects of the historical requisition data are the most important and what to use as a constraint or stopping point for the GenPac. The following is a concise description of the EBA process.

> The present development describes choice as a covert sequential elimination process. Suppose that each alternative consists of a set of aspects of characteristics, and that at every stage of the process, an aspect is selected (from those included in the available alternatives) with a probability that is proportional to its weight. The selection of an aspect eliminates all the alternatives that do not include the selected aspect, and the process continues until a single alternative remains. … Since the present theory describes choice as an elimination process governed by successive selection of aspects, it is called the elimination-by-aspects (EBA) model. (Tversky, 1972, p. 281)

This quote is how Amos Tversky himself described the EBA model in "Elimination by Aspects: A Theory of Choice." It shows how the decision itself is separated into distinct parameters or aspects with an aspect considered at each stage of the decision-making process. Each alternative in the decision that possesses neither the element nor a certain threshold pertaining to the element is eliminated, leaving only those alternatives that do qualify for further consideration. The process continues until only one alternative is left or a predetermined constraint is reached, with that one alternative or list of alternatives assumed to be the optimal outcome of the model.

In the case of this project, our constraint was the number of NSNs to cut the GenPac down to, considering the data that were available to us. Alternatively, the final constraint could be that the total weight of all NSNs, the total cost of all NSNs, the physical space available to the CLB on deployment, or another predetermined constraint had been achieved. The EBA model allows for the systematic consideration of all Class IX parts and a formalized process of eliminating items from the GenPac until an optimal list has been reached, according to all the parameters available in the historical data.

III. METHOD

The method that CLBs currently use to construct the GenPac that is used to build an MEU sustainment block starts with determining an equipment density listing (EDL), which is a list of all PEIs that the MEU will deploy with. Once the EDL is complete, with PEIs sorted by ID number, the SMU staff determines a percentage value for each PEI compared to the total number of that PEI resident in the Marine Expeditionary Force (MEF) EDL. Next, the SMU staff determines all Class IX parts necessary to conduct every possible maintenance event relating to all PEIs listed on the EDL. This listing is referred to as End Item Apps data. With this data, the SMU staff pulls the total historical quantities requisitioned by the MEF for every NSN listed within the End Item Apps data for the MEU. This historical MEF requisition listing is also known as the general account balance file (GABF). Lastly, the SMU staff uses the predetermined percentage value and multiplies it by the total quantity for the End Item Apps data found in the GABF, which results in the quantity for each NSN that the MEU will deploy with.

The main issue with this current method of constructing the MEU GenPac is that the MEF's GABF is not an accurate depiction of the historical requisition data necessary for a MEU. The MEF's GABF reflects maintenance events that are not seen in MEU units, such as PEI repairs due to routine training aboard major CONUS installations with improved road surfaces or new PEI operators learning to operate and repair their PEI. The MEF GABF data set is dependable if it is used in supporting an MEF in an environment that allows for intensive maintenance, but not for a deployed MEU that is limited in its maintenance potential.

For this project, our intent was to develop a model for determining the consumable maintenance items within the Class IX segment of an MEU sustainment block using historical requisition data from all seven MEUs and from units currently engaged in a kinetic environment supporting OEF. Using recent historical requisition data from all seven MEUs provided us a better snapshot of maintenance events taking place due to MEU operations that were conducted in all parts of the world and aboard

ARG ships. In addition, using recent historical requisition data from units currently engaged in a kinetic environment allowed us to simulate a full MEU tasked ashore to operate in a kinetic environment. This concept provides a better picture of the type and quantity of consumable Class IX items that should be placed in the consumable Class IX segment of an MEU sustainment block to meet the original intent of the sustainment block. This type of historical requisition data better portrays the original concept of a sustainment block, which is to support an MEU ashore for 15 days should the MEU be tasked by the NCA into an austere environment for operation within the ROMO.

A. DATA

We collected the data for this project primarily from the I Marine Expeditionary Force (I MEF) SASSY Management Unit (SMU) staff. Additionally, we collected Class IX sustainment block content from Combat Logistics Battalion 11 (CLB 11) and Combat Logistics Battalion 15 (CLB 15), which deployed sustainment blocks in support of WestPac 09-2 and WestPac 10-1, respectively. To establish a foundation for simulating MEU underway requisitions, we collected the actual historical requisition listings from CLB 11 and CLB 15 that resulted from their WestPac 09-2 and WestPac 10-1 deployments. Lastly, once we had collected all the data, an organic maintenance staff reviewed it to ensure the removal of all non-consumable Class IX maintenance items from all data sets.

In order to collect the required historical requisition data for all seven MEUs, we first needed to identify the activity address codes (AACs) for the Command Element (CE), the Battalion Landing Team (BLT), the CLB, and the Class IX sustainment block within each MEU. We also needed to determine the time period that each MEU was actively deployed, which is referred to as the time "on the water." Using these specific time periods, we could better identify the historical requisitions that were a direct result of deployed MEU operations.

Once we knew the AACs and deployment dates, we were able to utilize two databases to acquire the necessary information. The I MEF SMU used the Supported Activities Supply System (SASSY) database to gather the historical requisition data for

the three MEUs located on the west coast of the United States, the 11th, 13th, and 15th MEUs. The I MEF SMU then used the Birdtrack database, a supply chain management application implemented by Pacific Command, to gather the historical requisition data for the three MEUs located on the East Coast of the United States, the 22nd, 24th, and 26th MEUs, and the Okinawa, Japan-based MEU, the 31st MEU. We used the two different databases to collect the data necessary for this project due to a complication that the SMU staff experienced with the Birdtrack database when trying to retrieve historical requisition data for the 11th, 13th, and 15th MEUs. Because the SMU staff were unable to retrieve historical requisition data for the 11th, 13th, and 15th MEUs using the Birdtrack database, they opted to retrieve the necessary data from the SASSY database.

We used the Class IX sustainment block content from CLB 11 and CLB 15, which were deployed in support of WestPac 09-2 and WestPac 10-1, in order to compare all sustainment blocks built under our methodology versus sustainment blocks that were built and deployed under the current methodology. In addition, we collected the actual historical requisition listings resulting from WestPac 09-2 and WestPac 10-1 from CLB 11 and CLB 15 and used these listings in this project to develop simulated MEU deployment requisition data. We used the simulated requisition data to test all sustainment blocks built under our methodology to determine a positive or negative requisition fill response.

B. UNITS

In Table 1, we list the AACs for each of the four elements of the MEU and the dates that each MEU was deployed, or "on the water." We collected the AACs and dates located in Table 1 from the current or previous MEU and CLB supply staff. The 31st MEU has a separate listing of on-the-water dates because of its frequent deployments within the Pacific region, as listed in Table 2. When extracting data from the SASSY requisition database, we used the data in Table 1 for the first three units listed—the 11th, 13th, and 15th MEUs. When extracting data from the Birdtrack database, we used the data in Table 1 for the last four units listed—the 22nd, 24th, 26th, and 31st MEUs. We used data from both sources in the demonstration of our method.

Table 1. Activity Address Codes by MEU

MEU	11th MEU	13th MEU	15th MEU	22nd MEU	24th MEU	26th MEU	31st MEU
On-the-Water Dates	09/09–04/10	01/09–08/09	05/10–12/10	05/09–12/09	01/10–10/10	11/10–05/11	See Table 2
CE	M20177	M20310	M20173	M20179	M20180	M20181	M21075
BLT	M11170	M11140	M11120	M12130	M12260	M12230	MMJ132
CLB	M20195	M20196	M28391	M20197	M20199	M20198	M29048
IX Block	M28389	M28385	M28400	MML222	MML242	MML262	MMR122

Table 2. On-the-Water Dates for the 31st MEU

Infantry Battalion	Deployment Dates
2nd BN, 5th MAR	AUG–DEC 2009
2nd BN, 7th MAR	JAN–MAY 2010
1st BN, 7th MAR	JUN–DEC 2010
2nd BN, 5th MAR	JAN–MAY 2011
2nd BN, 7th MAR	JUN–DEC 2011

Using the SASSY database, the SMU staff collected AAC data in order to identify current requisition data in a kinetic environment. In Table 3, we list the AACs for units operating in support of OEF over a 12-month period. The I MEF SMU identified these units in order to represent, as closely as possible, a full MEU operating ashore in a kinetic environment. Due to the current OEF operating environment, there are certain MEU-type units (e.g., Amphibious Assault Vehicles [AAV]) that are not operating in a kinetic environment, so we relied on non-kinetic historical requisition data for Class IX parts associated with those units.

Table 3. Activity Address Codes Used for Kinetic Usage Data

Kinetic AACs	
3rd LAR BN	M95103
2nd Recon	M95109
ARTYBNB	M95114
CLB 3	M95301
Tanks	M95307

C. DATA PARAMETERS

With the necessary AACs and deployment dates collected for the required units, the SMU staff created a database that lists the historical requisition data for all seven MEUs separately and for the MEU ashore in a kinetic environment. Within this database, the SASSY requisition data collected by the SMU staff, shown in Figure 1, displayed four key components for each consumable Class IX item. Those components were the number of requisitions placed within the time frame (hits), the total quantity ordered from all requisitions (demands), the Combat Essentiality Code (CEC), and the average customer wait time (ACWT), which is found by taking the average wait time from all hits for a specific NSN. We explain these components in greater detail later in this section. The Birdtrack requisition data collected by the SMU staff, shown in Figure 2, displayed seven key components for each consumable Class IX item. Those components included the four that the SASSY requisition data produced as well as the price per NSN (unit price), the total price found by multiplying the unit price and the total demands (extended price), and the weighting factor, which is found by multiplying the hits by the ACWT.

	A	B	C	D	E	F
1	NSN	NOMEN	HITS	DEMANDS	CEC	AvgOfCWT
2	1005001186192	FIRING ATTACHMENT,B	1	125	5	21
3	1005002099691	SPRING	2	10	0	22
4	1005003127177	SLING,SMALL ARMS	4	20	2	17
5	1005003229716	MOUNT,TRIPOD,MACHIN	1	15	0	34
6	1005003368608	LEAF,REAR SIGHT	3	11	5	11
7	1005003504100	BRUSH,CLEANING,SMAL	4	31	5	19
8	1005004030964	SWIVEL,SLING,SMALL	1	1	5	17
9	1005004946602	BRUSH,CLEANING,SMAL	3	30	5	20
10	1005005013692	HELICAL,TORSION	1	1	5	6
11	1005005140428	SPRING,LOCKING,ELEV	1	5	5	32
12	1005005504037	BRUSH,CLEANING,SMAL	2	11	2	17
13	1005005506573	CASE,SMALL ARMS CLE	2	28	2	11
14	1005005508141	ACCELERATOR,MACHINE	2	8	5	10
15	1005005564102	ROD,CLEANING,SMALL	2	12	5	16
16	1005005564174	BRUSH,CLEANING,SMAL	2	60	2	21
17	1005005564305	ROD ASSEMBLY,OPERAT	2	10	5	30
18	1005006008928	LATCH,COVER	2	6	5	36
19	1005006008935	COVER,GUNSIGHT	1	5	2	76
20	1005006034834	ELEVATING AND TRAVE	1	5	2	20
21	1005006147583	CAM,BREECHLOCK,MACH	1	5	5	13
22	1005006313800	HANDLE	1	1	5	14
23	1005006535441	ROD,CLEANING,SMALL	1	10	2	15
24	1005006903115	BRUSH,CLEANING,SMAL	1	10	5	23
25	1005007141245	SLING,SMALL ARMS	2	4	2	56
26	1005007161302	LOCK,BREECH,MACHINE	1	4	5	10
27	1005007162097	COVER,ELEVATOR TOP	1	2	2	31

Figure 1. SASSY Data Sample

	A	B	C	D	E	F	G	H
1	RNSN	HITS	DEMANDS	UNIT PRICE	EXTENDED PRICE	ACWT	WEIGHTING FACTOR	CEC
2		1	1	8.03	8.03	39	39	
3		1	10	64.73	647.3	87	87	
4	1005002876527	1	1	928.38	928.38	31	31	5
5	1005003488653	1	1	963	963	33	33	5
6	1005004030964	1	15	5.21	78.15	18	18	5
7	1005005504037	1	1	0.56	0.56	38	38	2
8	1005005504082	1	1	581.59	581.59	33	33	5
9	1005006147463	1	1	649	649	33	33	5
10	1005007266134	1	5	14.58	72.9	30	30	5
11	1005011285721	1	20	12.61	252.2	33	33	5
12	1005011311908	1	15	4.74	71.1	33	33	5
13	1005011343625	1	25	6.8	170	18	18	5
14	1005012360238	1	20	9.56	191.2	33	33	5
15	1005012519180	1	1	3.1	3.1	31	31	5
16	1005012549801	1	15	50.18	752.7	18	18	5
17	1005013776585	2	2	99.73	199.46	22.5	45	
18	1005014610328	1	15	100	1500	33	33	5
19	1005014612656	1	2	105	210	4	4	
20	1005015267354	1	60	75.27	4516.2	41	41	
21	1010011229555	3	20	21.4	428	12.33333333	37	5
22	1010011229556	3	22	9.78	215.16	9	27	5
23	1010011229677	1	4	34.45	137.8	33	33	
24	1010011236697	2	21	9.98	209.58	12.5	25	5
25	1010011236705	1	1	219	219	2	2	5
26	1010011291233	4	8	245	1960	6	24	5
27	1010011291247	2	6	245	1470	10	20	5

Figure 2. Requisition Data From Birdtrack for the 22nd, 24th, 26th, and 31st MEUs

The last two sections of the database created by the SMU staff contained a listing of the combined historical requisition data for all seven MEUs and the requisition data for the MEU ashore in a kinetic environment. The combined MEU requisition data displayed the SASSY key components, listed in the previous paragraph, and three additional components as seen in Figure 3. Those additional components listed unit price, how many times the item was ordered under a deadlined or degraded maintenance code (deadline-degraded), and the number of MEUs that ordered the particular NSN (frequency). The SASSY requisition data collected for the MEU ashore in a kinetic environment displayed the same key components as the requisition data for the combined MEUs, minus ACWT and frequency. This data set can be seen in Figure 4.

	A	B	C	D	E	F	G	H	I
1	NSN	NOMEN	HITS	DEMANDS	CEC	AVGCWT	DEADLINE_DEGRADED	FREQUENCY	U_P
2	5340015319844	BRACKET,MOUNTING	1	1	5	245	1	1	99.56
3	5935015529132	CONNECTOR,PLUG,ELEC	1	1	5	242	0	2	520.97
4	5995015528008	CABLE ASSEMBLY,SPEC	1	1	5	242	0	1	427.59
5	5995015531304	CABLE ASSEMBLY,SPEC	1	1	5	242	0	1	11062.50
6	6140014768945	BATTERY,STORAGE	4	6	2	36	86	1	359.54
7	5325015237504	GROMMET,NONMETALLIC	1	2	5	233	3	1	2.02
8	5920015532311	LIGHTNING ROD	1	1	5	216	0	1	195.89
9	5999015012536	CAP,ELECTRICAL	1	4	5	190	0	1	30.98
10	5985015590074	ANTENNA	1	3	5	185	18	1	1436.74
11	5995015590085	CABLE ASSEMBLY,SPEC	1	3	5	167	0	1	655.20
12	2540014136985	COVER,FITTED,VEHICU	1	1	5	160	0	1	688.83
13	2520219063932	CONTROL ASSEMBLY,TR	1	5	5	153	2	4	267.01
14	5330015675010	GASKET	1	1	5	147	0	2	8.04
15	5995015527735	CABLE ASSEMBLY,SPEC	1	1	5	147	0	3	438.65
16	4120015322047	REMOTE ASSY	1	1	5	144	10	1	1174.25
17	4820011580766	VALVE,REGULATING,FL	1	1	5	139	5	1	317.94
18	5920015527710	LIGHTNING ROD	1	1	5	136	0	1	71.27
19	2590004026024	PAD,CUSHIONING	3	4	2	31	64	6	21.82
20	5340011930251	BRACKET,ANGLE	1	1	5	131	1	1	22.69
21	4720015220858	HOSE ASSEMBLY,METAL	1	1	5	130	0	1	42.61
22	6150015478950	CABLE ASSEMBLY,SPEC	1	6	5	124	7	2	2352.00
23	5315015533091	PIN,QUICK RELEASE	1	1	5	124	1	2	73.59
24	3110015253635	BEARING,ROLLER,TAPE	1	1	5	122	3	3	109.00
25	2540014956751	WIPER MOTOR,TWO SPE	1	1	5	121	5	1	475.09
26	5935006266103	COVER,ELECTRICAL CO	4	4	2	8	54	1	18.91
27	6150015131365	CABLE ASSEMBLY,SPEC	13	37	2	34	54	2	407.59
28	6145015561263	CABLE,POWER,ELECTRI	1	1	5	120	1	1	90.36
29	5340015719766	BRACKET,MOUNTING	1	26	5	119	0	2	69.26
30	5920015527728	LIGHTNING ROD	1	2	5	119	0	1	105.34
31	5330014802335	SEAL,PLAIN ENCASED	2	3		8	52	2	6.74
32	5330014802368	SEAL,PLAIN	2	3		11	52	3	4.66

Figure 3. Combined MEU Requisition Data

	A	B	C	D	E	F	G
1	NSN	NOMEN	HITS	DEMANDS	CEC	DEADLINE_DEGRADED	U_P
2	1005000179540	DETENT,PAWL	1	1	5	0	0.87
3	1005000179543	SWIVEL,SLING,SMALL	3	30	5	9	3.16
4	1005000179546	HANDLE ASSEMBLY,CHA	2	20	5	0	19.94
5	1005000179547	PIN,FIRING	9	192	5	0	14.03
6	1005000179548	CATCH,BOLT	1	1	5	0	13.28
7	1005000179551	HAMMER,FIRING,SMALL	6	10	5	0	12.51
8	1005000506357	ROD SECTION,CLEANIN	8	30	5	0	20.29
9	1005000562247	PLUNGER,BOLT CATCH	1	1	5	0	0.43
10	1005000878998	RING,SLIP,HAND GUAR	3	30	5	1	5.75
11	1005002098720	SPRING	3	40	5	5	0.30
12	1005002099691	SPRING	2	45	0	0	0.19
13	1005002883565	SWAB,SMALL ARMS CLE	6	24	5	0	15.83
14	1005003229716	MOUNT,TRIPOD,MACHIN	9	81	0	0	757.00
15	1005004030964	SWIVEL,SLING,SMALL	27	318	5	1	3.57
16	1005004946602	BRUSH,CLEANING,SMAL	17	464	5	0	0.48
17	1005005009300	SPRING	2	2	0	0	0.12
18	1005005009351	SPRING	9	45	0	1	0.42
19	1005005013154	HELICAL,COMPRESSION	1	1	0	1	0.19
20	1005005013155	PLUNER,DETENT	2	2	5	1	1.06
21	1005005013539	STOP,CARTRIDGE	3	15	5	1	7.91
22	1005005013692	HELICAL,TORSION	3	3	5	2	0.57
23	1005005140209	A0	11	12	5	0	0.65
24	1005005140211	A0	20	71	5	0	3.34
25	1005005140215	A0	1	20	5	0	0.22
26	1005005140216	A0	2	40	5	0	54.53
27	1005005504067	SEAR	3	13	5	2	11.34

Figure 4. MEU Kinetic Environment Requisition Data

In this project, we chose not to focus in detail on the issues of cost or the materiel footprint of the MEU sustainment block because, although both are extremely important, they are complex enough to require their own specific project. When addressing the cost of the sustainment block, there is the easily identifiable issue of the cost per item in the block, which results in the total cost for the sustainment block. Although adjusting the size of the sustainment block will either increase or decrease the total cost of the block, other, less easily identifiable, costs also affect the total cost of the sustainment block and must be taken into account when adjusting the sustainment block. Those costs include the material handling cost at every point along the sustainment block building process—starting when the block is ordered by the CLB all the way through the current turn-in process. Another cost requiring examination is the shipping cost associated with a larger or smaller sustainment block once a ship is underway. Lastly, the most important cost is the impact of a larger or smaller sustainment block upon the ARG/MEU team. A sustainment block that is either larger or smaller than usual because it was constructed based solely on cost could impact the readiness of the MEU, which could have a large positive or negative impact. Also, a larger or smaller sustainment block would take up more or less space aboard ARG ships, which would decrease or increase the number of combat-essential PEIs carried by the MEU. A decrease or increase in the number of

combat-essential PEIs carried by the MEU would have a negative or positive affect on the ARG/MEU. The database used in this project includes basic price per unit cost data because the SMU staff was able to pull this information from both SASSY and Birdtrack, but all of the other costs mentioned in this paragraph are more complex to collect.

Materiel footprint, like cost, has some easily identifiable features that can be addressed when talking about adjusting the MEU sustainment block, but there are also less easily identifiable features about footprint. If it were necessary to adjust an MEU sustainment block, a supply officer could simply use the total national stock number (NSN) count or total line-item count to determine if the sustainment block were larger or smaller than the previous sustainment block. However, total numbers alone are not sufficient enough to determine a positive or negative impact on overall footprint for the MEU sustainment block. All sustainment block items must be stored in either a pallet container (PALCON) or a quadruple container (QUADCON) prior to being loaded onto ARG ships. With multiple packing requirement restrictions, such as hazardous material (HAZMAT) requirements or cubic weight restrictions for material handling equipment (MHE) aboard ARG ships, simply adding or reducing NSNs/line items does not mean the total number of PALCONs or QUADCONs will be reduced, or that the overall footprint will be reduced. Also, the footprint parameters for each MEU sustainment block are different because each MEU has space restrictions passed down by ARG and MEU staffs that are specific to the ships within that ARG/MEU team. The database used in this project did not have any data relating to the footprint of the sustainment block because the SMU staff was not able to gather the weight or cube measurement of specific NSNs from SASSY or Birdtrack.

Due to the complexities of both cost and footprint, we designed this project to focus on a method or model to improve the MEU sustainment block building process rather than to determine a one-size-fits-all sustainment block. In this project, we propose a model with easy-to-explain criteria and a clear methodology to help CLB supply staffs develop an accurate initial GenPac listing of consumable Class IX repair parts for their sustainment block. By using this initial GenPac listing, the CLB supply staff will then be

able to input their specific cost and footprint restrictions to determine the best listing of consumable Class IX repair parts to be placed in their sustainment block.

For this project, we focused on the last two sections of the database created by the SMU staff: the combined historical requisition data for all seven MEUs and the requisition data for the MEU ashore in a kinetic environment. We chose to focus on the hits, demands, CEC, frequency, and deadline-degraded categories because these factors are the most important when determining the impact of carrying a specific Class IX item in the sustainment block.

The hits category is an important determination factor in our methodology because it allows for an understanding of the frequency with which the NSN has been ordered. If an NSN had a high number in the hits column, we assumed that the NSN had been ordered a sufficient number of times to warrant further investigation, as illustrated in Figure 5. A high number in this column meant that we needed to identify if the NSN was ordered by only one MEU or by multiple MEUs, showing a common trend across the maintenance community. Also, we wanted to determine if the NSN was ordered because it was a critical Class IX repair part that deadlined or degraded a PEI.

	K	L	M	N	O	Q	R	S	T
2	NSN	NOMEN	HITS	DEMANDS	CEC	DEADLINE_DEGRADED	FREQUENCY	U_P	SOURCE
3	2930-01-448-9439	RADIATOR,ENGINE COO	3	3		52	1		C
4	5310-00-834-8732	NUT,PLAIN,HEXAGON	3	3		6	1		C
5	5315-00-501-3523	PIN,STRAIGHT,HEADLE	3	3		4	1		C
6	6160-01-461-9622	COVER,BATTERY BOX	3	3		5	1		C
7	1005-00-501-3692	HELICAL,TORSION	3	3	5	2		0.57	K
8	1005-00-614-7893	SLIDE,RETRACTING	3	3	5	2		15.09	K
9	1005-00-726-6131	BARREL,MACHINE GUN	3	3	5	3	1	1064.00	M
10	2510-01-432-3338	HOOD,ENGINE COMPART	3	3	5	28	1	1949.00	M
11	2510-01-533-4686	WINDOW ASSEMBLY,RH	3	3	5	32	1	2498.06	M
12	2510-01-545-5898	WINDOW,VEHICULAR	3	3	5	11	1	1391.00	M
13	2520-01-473-0594	CONTROL ASSEMBLY,TR	3	3	5	3		4249.81	K
14	2520-01-479-4574	PROPELLER SHAFT WIT	3	3	5	5	1	486.80	M
15	2530-01-474-5709	BRAKE SHOE	3	3	5	6		606.10	K
16	2530-01-542-3402	HORN BUTTON,VEHICLE	3	3	5	8		24.57	K
17	2530-01-565-9660	CALIPER,DISC BRAKE	3	3	5	7		400.21	K
18	2540-01-135-7387	HANDLE,DOOR,VEHICUL	3	3	5	16	3	109.52	M
19	2540-01-152-7764	LATCH,HOOD,VEHICULA	3	3	5	12	1	1.74	M
20	2540-01-203-7721	HANDLE,DOOR,VEHICUL	3	3	6	4	2	2.33	M
21	2540-01-355-6593	ARM,DIRECTIONAL SIG	3	3	5	33	1	58.41	M
22	2540-01-461-8220	GUARD,SPLASH,VEHICU	3	3	6	4	1	34.58	M
23	2540-01-479-2021	CUSHION,SEAT BACK,V	3	3	5	7		125.71	K
24	2540-01-495-6743	WIPER BLADE	3	3	5	17	3	92.54	M
25	2540-01-495-6743	WIPER BLADE	3	3		17	3		C
26	2540-01-495-6784	MIRROR,REARVIEW	3	3	5	2	2	99.68	M
27	2540-01-555-4433	SEAT,VEHICULAR	3	3	5	2		95.82	K
28	2910-01-488-7002	FILTER,FLUID	3	3		5	1		C

Figure 5. Sustainment Block Built Using the EBA Model

The demands category is an important determination factor in our methodology because it allows for an understanding of the quantity in which an NSN is ordered. If an NSN had a high number in this column, we assumed that the NSN was needed in a large quantity, regardless of how many hits occurred. This column helps to balance the hits column by showing whether the NSN was packaged in bulk quantity, which shows a higher demand for the NSN than looking solely at the hits column. As with the hits column, demand was important because it allowed us to identify whether we needed further research for a particular NSN to determine if it was ordered by only one MEU or by multiple MEUs. Also, demand helped us to identify further research needed to show whether an NSN deadlined or degraded a PEI, which could indicate a trend across the maintenance community.

The CEC category is an important determination factor in our methodology because it allows for an understanding of the importance of the NSN as set forth by Headquarters, Marine Corps (HQMC). By definition, the CEC categories are used to establish that an item is essential to the operational readiness of a weapon system or the conduct of a military mission, or that a functional part contributes to the tactical and essential operations of an end item component or assembly, and its failure would render the end item inoperable or incapable of fulfilling its mission (USMC, 1984, p. 4-4-20). Table 4 contains the eight CEC categories listed by HQMC and their respective definitions.

Table 4. Combat Essentiality Codes
(USMC, 1984, p. 4-4-20)

Code	Definition
0	Non-Combat-Essential End Item: End items that do not fit the definition of Code 1 items.
1	Combat-Essential End Item: End-item equipment whose availability in a combat-ready condition is essential for execution of the combat and training missions of the command.
2	Non-Critical Repair Part: Repair parts or major components whose failure in an end item will not render the end item inoperative or reduce its effectiveness below

	the minimum acceptable level of efficiency, and which do not fit the definition of Code 3 or 4 items.
3	Critical for Health and Safety of Personnel: Those parts and components required for the health and safety of personnel that do not fit the definition of Code 5 or 6 items.
4	Critical for State and Local Laws: Those parts and components required for conformance to state law or local ordinances that do not fit the definition of Code 5 or 6 items.
5	Critical Repair Part to a Combat-Essential End Item: Those parts or components whose failure in a combat-essential end item will render the end item inoperative or reduce its effectiveness below the minimum acceptable level of efficiency.
6	Critical Repair Part to a Non-Combat-Essential End Item: Those parts or components whose failure in a non-combat-essential end item will render the end item inoperative or reduce its effectiveness below the minimum acceptable level of efficiency.
7	Unassigned Item: An item that has been reviewed and determined not to fit the definition of Codes 0–6. These items are not assigned a specific application within the Marine Corps.

We also considered the deadline-degraded category as an important determination factor in our methodology because it allows for a balance when used with the CEC category. The deadlining-degrading categories, or Non-Mission Capable Supply (NMCS) indicators, are defined in the *Ground Equipment Record Procedures Manual* (USMC, 1992). The NMCS categories, when used correctly, indicate to the organic supply staff whether requested NSNs are the maintenance parts that are actually deadlining a PEI. While the CEC codes identify that a specific NSN has the ability to deadline or degrade a PEI, the NMCS code is used by the maintenance staff conducting the repairs to identify whether a specific NSN is responsible for the current deadlined or degraded state of the PEI. These codes are also designed to help the intermediate source of supply determine the criticality of the NSN and determine the mode of shipment for the NSN. The NMCS codes are designed to work hand–in-hand with the unit's priority codes.

For this project, we focused on the NMCS codes labeled 9, N, and E, also referred to as deadlined or degraded. The NMCS code of 9 is only authorized for use when a unit is located outside the continental United States (OCONUS) and has a priority code of 01, 02, or 03, or is a CONUS unit deploying within 30 days. The NMCS code of N is only authorized for use when a unit is located OCONUS with a priority code of 05 or is a CONUS unit with a priority code of up to 09. Both the NMCS codes 9 and N indicate that a PEI is Non-Mission Capable (NMC), which is also referred to as deadlined. The NMCS code of E is used to indicate that a PEI will be NMC, also referred to as degraded, within 15 days while in CONUS or within 20 days of being OCONUS. We chose to focus on NMCS codes 9, N, and E because they indicate all Class IX repair parts that a requesting unit deemed as critical to a particular maintenance event. The NMCS column helps to balance the CECs because NMCS codes are more flexible then CECs. CECs are objective as they are set by HQMC, while NMCS codes are subjective, which allows them to better depict actual maintenance staff opinions and needs. The NMCS codes are subjective because they can be assigned based on the opinion of the commander or maintenance staff with respect to equipment that is considered mission essential, impacting unit readiness.

The final category used in this project was frequency, which we considered an important determination factor in our methodology because it allowed for an understanding of the commonality across all seven MEUs for a particular NSN. The higher the number in this column, the more MEUs ordered that particular NSN. This number demonstrated that a particular NSN had been requisitioned by different MEUs at different time periods across the entire range of mission sets with which an MEU can be tasked.

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IV. ANALYSIS

In this project, we proposed a different method for building a GenPac for the MEU sustainment block in order to reduce the number of NSNs carried, but without reducing the effectiveness of the sustainment block in filling ARG/MEU underway Class IX requisitions. Our GenPac method is founded on the goal of not using MEF GABF requisition data and, instead, using actual historical Class IX requisition data from all seven MEUs and from Marine Corps units recently engaged in the kinetic environment supporting OEF. To test our method, we created multiple GenPacs using the specific data mentioned in Chapter III, created simulated requisition data, and compared fill rates between our GenPac and actual sustainment blocks that were built using the current GenPac method.

A. REQUISITION DATA

As we mentioned in Chapter III, after collecting the necessary historical requisition data from all seven MEUs and from MEU ashore units, we collected the requisition lists that resulted from actual MEU deployments. CLB 11 deployed with the 11th MEU in support of WestPac 09-2, and CLB 15 deployed with the 15th MEU in support of WestPac 10-1. Both WestPac 09-2 and WestPac 10-1 were standard seven-month long MEU deployments in which the MEU conducted training exercises in multiple locations throughout their deployment period. Neither the 11th MEU nor the 15th MEU were engaged in a kinetic environment; however, the 15th MEU was tasked to support the Humanitarian Assistance and Disaster Relief (HADR) efforts in Pakistan in 2010 due to flooding.

An organic maintenance staff reviewed both CLB requisition lists to remove all requisitions that were not consumable Class IX items. After the maintenance staff reviewed the lists, we combined both lists and found all the NSNs that appeared as duplicates on both lists. For each set of duplicate NSNs, we took the average for the respective hits and demands. Once we had corrected average hits and demands for all

duplicate NSNs, we inserted the duplicates back into the combined CLB requisition list. The reviewed CLB requisition list was then used as the data pool for generating simulated deployed MEU requisitions, which we explain in Section C.

B. GENPAC CREATION

To validate our research question, we built a proposed GenPac(s) from the data sources listed in Chapter III, rather than from MEF GABF historical requisitions, which is the current method. Using the requisition databases (Combined MEU Usage and Kinetic) created by the SMU staff, we built multiple GenPacs focusing on different levels of CECs, hits, and NMCS codes as our key aspects.

We started with two basic assumptions when creating our GenPacs. The first assumption was that building a GenPac using our proposed method would result in a higher overall Class IX requisition fill rate than a GenPac built under the current method. Our second assumption was that a GenPac built with only CEC 5 and 6 NSNs, using our proposed method, would produce a higher fill rate for simulated CEC 5 and 6 Class IX requisitions than a GenPac built under the current method. In order to test our theory, we created two sets of GenPacs: one set focused on CECs and the other set focused on hits. Within these two sets of GenPacs, we created a total of 18 GenPacs of varying degrees to establish fair comparisons against the CLB 11 and CLB 15 MEU sustainment blocks built using the current GenPac method.

To test our first assumption regarding a higher overall Class IX requisition fill rate, we created GenPacs focusing on the numbers of hits each NSN received. We established a fair comparison against CLB 11 and 15 by creating a GenPac with a total NSN count with a 10% plus or minus range of the NSN count within the CLB 15 MEU sustainment block, and a GenPac with a total NSN count with a 10% plus or minus range of the NSN count within the CLB 11 MEU sustainment block. Next, we created a GenPac with a total NSN count with a 10% plus or minus range of 1,000 NSNs to present a proposed baseline, fill rate, and size for a sustainment block that would have a smaller materiel footprint and smaller initial ordering cost. Lastly, for this assumption, we ensured that each GenPac had a total line-item count as close to its respective CLB MEU

sustainment block comparison as possible. The total line-item count is significant because a GenPac with 10 times the line items is not an equal comparison due to the possibility of inflated fill rates and the unrealistic materiel footprint. To determine the total line-item count within a GenPac, we summed all demands within the GenPac. We found that our proposed GenPacs had excessive total line-item counts because the demands from the Combined MEU Usage database were a sum total of all demands across the seven MEUs. To correct for this artifact, we divided all line-item counts in the GenPacs we built by seven. Of course, more sophisticated approaches are possible. For example, we could have examined the between-MEU variability in demands and set line-item counts to some value above the mean (e.g., that level required by the 2nd highest demand among all MEUs) in order to more explicitly maximize fill rates. But this would have increased footprint and cost as well, and an examination of that trade-off was beyond the scope of the thesis.

To test our second assumption regarding a higher fill rate for simulated CEC 5 and 6 Class IX requisitions, we created GenPacs focused on only NSNs with CECs 5 and 6. To establish a fair comparison between these simulated GenPacs and current GenPacs, we followed the same methodology here as we did with the GenPacs built focusing on hits. We created a GenPac with a total NSN count with a 10% plus or minus range of the NSN count within the CLB 15 MEU sustainment block, and a GenPac with a total NSN count with a 10% plus or minus range of the NSN count within the CLB 11 MEU sustainment block. Next, we created a GenPac with a total NSN count with a 10% plus or minus range of 1,000 NSNs to present a proposed baseline, fill rate, and size for a sustainment block that would have a smaller materiel footprint and smaller initial ordering cost.

For the final step in our GenPac building process, we wanted to demonstrate the impact of the different requisition databases used in our methodology. We re-created all three GenPacs for the first assumption and all three GenPacs for the second assumption two times, but used only the Combined MEU Usage requisition database and the Kinetic requisition database, respectively. We created these 12 GenPacs to show the impact of

using requisition data from each database separately compared to the impact of using requisition data from the combination of the two databases.

1. Hits-Focused GenPac

To demonstrate the possible benefits of using accurate historical requisitions data in this project, we created three primary proposed GenPacs focused on the number of hits for an NSN. To begin, we combined the Combined MEU Usage and Kinetic requisition databases and identified all duplicate NSNs. As with the data pool for simulating requisitions, we averaged all duplicate NSNs' hits and demands, respectively, to account for the duplication.

We created nine GenPacs focused on hits in order to test our first assumption regarding overall fill rates. The first three proposed hits-focused GenPacs started with the combined requisition listing of the Combined MEU Usage and Kinetic requisition databases. To construct a GenPac, we needed a target number of NSNs. Since the EBA criteria are ordinal, the target will never be met exactly, so we needed to either set an acceptable range around the target, or treat the target as a maximum. We arbitrarily set an acceptable range around each target of plus-or-minus 10%. Since there are costs to carrying too few or too many NSNs, we felt a range around the target was more effective than stating a maximum threshold for the target. The first proposed GenPac had a target NSN goal of 2,294 plus-or-minus 10%. We began by filtering out all NSNs that had a 1 or lower in the hits column, which resulted in 7,571 NSNs. Next, we applied the filtering process to the deadline-degraded category, in which we removed all NSNs with a 1 or lower, which resulted in 2,139 NSNs remaining from the original 13,381. The second proposed GenPac had a target NSN goal of 1,410 plus-or-minus 10%. We began by filtering out all NSNs that had a 2 or lower in the hits column, which resulted in 4,535 NSNs. Next, we applied the same filtering process to the deadline-degraded category by removing all NSNs with a 1 or lower, which resulted in 1,446 NSNs remaining from the original 13,381. The final proposed GenPac in this group had a target NSN goal of 1,000 plus-or-minus 10%. We began by filtering out all NSNs that had a 3 or lower in the hits column, which resulted in 3,169 NSNs. Next, we applied the same filtering process to

the deadline-degraded category by removing all NSNs with a 1 or lower, which resulted in 1,061 NSNs remaining from the original 13,381.

The next three proposed hits-focused GenPacs started with only the requisitions from the Combined MEU Usage database. The first proposed GenPac had a target NSN goal of 2,294 plus-or-minus 10%. We began by filtering out all NSNs that had a zero or lower in the hits column, which resulted in 2,300 NSNs remaining from the original 5,992. As the first filtering process resulted in an NSN count close enough to the target NSN count, we did not apply any further filters to this GenPac. The second proposed GenPac had a target NSN goal of 1,410 plus-or-minus 10%. Again, we began by filtering out all NSNs that had a zero or lower in the hits column, which resulted in 2,300 NSNs. Next, we applied the filtering process to the deadline-degraded category by removing all NSNs with a zero or lower, which resulted in 1,516 NSNs remaining from the original 5,992. The final proposed GenPac in this group had a target NSN goal of 1,000 plus-or-minus 10%. We began by filtering out all NSNs that had a zero or lower in the hits column, which again resulted in 2,300 NSNs. Next, we applied the filtering process to the deadline-degraded category by removing all NSNs with a 2 or lower, which resulted in 1,048 NSNs remaining from the original 5,992.

The final three proposed hits-focused GenPacs started with only the requisitions from the Kinetic database. The first proposed GenPac had a target NSN goal of 2,294 plus-or-minus 10%. We began by filtering out all NSNs that had a 4 or lower in the hits column, which resulted in 2,217 NSNs remaining from the original 9,359. As the first filtering process resulted in an NSN count close enough to the target NSN count, we did not apply any further filters to this GenPac. The second proposed GenPac had a target NSN goal of 1,410 plus-or-minus 10%. We began by filtering out all NSNs that had a 2 or lower in the hits column, which resulted in 3,982 NSNs. Next, we applied the filtering process to the deadline-degraded category by removing all NSNs with a zero or lower, which resulted in 1,447 NSNs remaining from the original 9,359. The final proposed GenPac in this group had a target NSN goal of 1,000 plus-or-minus 10%. Again, we began by filtering out all NSNs that had a 2 or lower in the hits column, which resulted in 3,982 NSNs. Next, we applied the filtering process to the deadline-degraded category by

removing all NSNs with a 1 or lower, which resulted in 1,053 NSNs remaining from the original 9,359.

We used the sustainment blocks carried by CLB 11 and CLB 15 during WestPac 09-2 and WestPac 10-1 as the basis of comparison, and we tested all nine of the proposed hits-focused GenPacs using simulated deployment requisitions. The details of the model built to test all nine proposed GenPacs focusing on hits and the results of that model are explained in detail in Sections C and D of this chapter.

2. CEC-Focused GenPac

As with the hits-focused GenPacs, the first three proposed CEC-focused GenPacs started with the combined requisition listing of the Combined MEU Usage and Kinetic databases. The first proposed GenPac had a target NSN goal of 2,294 plus-or-minus 10%. We began by filtering out all NSNs that had a CEC other than 5 or 6 in the CEC column, which resulted in 8,661 NSNs. Next, we applied the filtering process to the hits category and removed all NSNs with a 1 or lower, which resulted in 4,968 NSNs. We applied the final filtering process to the deadline-degraded category and removed all NSNs with a zero, which resulted in 2,205 NSNs remaining from the original 13,381. The second proposed GenPac had a target NSN goal of 1,410 plus-or-minus 10%. Again, we began by filtering out all NSNs that had a CEC other than 5 or 6 in the CEC column, which resulted in 8,661 NSNs. Next, we applied the filtering process to the hits category and removed all NSNs with a 2 or lower, which resulted in 2,947 NSNs. We applied the final filtering process to the deadline-degraded category and removed all NSNs with a zero, which resulted in 1,410 NSNs remaining from the original 13,381. The final proposed GenPac in this group had a target NSN goal of 1,000 plus-or-minus 10%. Once again, we began by filtering out all NSNs that had a CEC other than 5 or 6 in the CEC column, which resulted in 8,661 NSNs. Next, we applied the filtering process to the hits category and removed all NSNs with a 2 or lower, which resulted in 2,947 NSNs. We applied the final filtering process to the deadline-degraded category and removed all NSNs with a 1 or lower, which resulted in 1,100 NSNs remaining from the original 13,381.

The next three proposed CEC-focused GenPacs started with only the requisitions from the Combined MEU Usage database. The first proposed GenPac had a target NSN goal of 2,294 plus-or-minus 10%. We began by filtering out all NSNs that had a CEC other than 5 or 6 in the CEC column, which resulted in 4,181 NSNs. Next, we applied the filtering process to the deadline-degraded category in which we removed all NSNs with a zero or lower, which resulted in 2,403 NSNs remaining from the original 5,992. The second proposed GenPac had a target NSN goal of 1,410 plus-or-minus 10%. Again, we began by filtering out all NSNs that had a CEC other than 5 or 6 in the CEC column, which resulted in 4,181 NSNs. Next, we applied the filtering process to the hits category and removed all NSNs with a zero or lower, which resulted in 1,681 NSNs remaining from the original 5,992. The final proposed GenPac in this group had a target NSN goal of 1,000 plus-or-minus 10%. Once again, we began by filtering out all NSNs that had a CEC other than 5 or 6 in the CEC column, which resulted in 4,181 NSNs. Next, we applied the filtering process to the hits category and removed all NSNs with a zero or lower, which resulted in 1,681 NSNs. We applied the final filtering process to the deadline-degraded category and removed all NSNs with a zero or lower, which resulted in 1,117 NSNs remaining from the original 5,992.

The final three proposed CEC-focused GenPacs started with only the requisitions from the Kinetic database. The first proposed GenPac had a target NSN goal of 2,294 plus-or-minus 10%. Again, we began by filtering out all NSNs that had a CEC other than 5 or 6 in the CEC column, which resulted in 5,976 NSNs. Next, we applied the filtering process to the hits category and removed all NSNs with a 2 or lower, which resulted in 2,542 NSNs remaining from the original 9,359. The second proposed GenPac had a target NSN goal of 1,410 plus-or-minus 10%. We began by filtering out all NSNs that had a CEC other than 5 or 6 in the CEC column, which resulted in 5,976 NSNs. Next, we applied the filtering process to the hits category and removed all NSNs with a 1 or lower, which resulted in 3,982 NSNs. We applied the final filtering process to the deadline-degraded category and removed all NSNs with a zero, which resulted in 1,485 NSNs remaining from the original 9,359. The final proposed GenPac in this group had a target NSN goal of 1,000 plus-or-minus 10%. Once again, we began by filtering out all

NSNs that had a CEC other than 5 or 6 in the CEC column, which resulted in 5,976 NSNs. Next, we applied the filtering process to the hits category and removed all NSNs with a 2 or lower, which resulted in 2,542 NSNs. We applied the final filtering process to the deadline-degraded category and removed all NSNs with a zero or lower, which resulted in 1,065 NSNs remaining from the original 9,359.

After completing all nine proposed CEC-focused GenPacs, we identified two GenPacs that did not meet our target NSN range of plus or minus 10%. The first GenPac we identified was the second CEC-focused GenPac built using MEU- only requisition data. This GenPac resulted in an NSN count of 1,681, which was 80 NSNs over the plus or minus 10% range of 1,601. Due to the additional NSNs, this GenPac was actually 15.5% over the 1,455-NSN count found in the CLB 11 sustainment block. The second proposed CEC-focused GenPac we identified was the first CEC-focused GenPac built using the Kinetic database only. This GenPac resulted in an NSN count of 2,542, which was 19 NSNs over the plus or minus 10% range of 2,523. Due to the additional NSNs, this GenPac was actually 10.8% over the 2,294-NSN count found in the CLB 15 sustainment block.

We reviewed both GenPacs that broke the plus-or-minus 10% range in order to determine if it was possible to reapply the EBA selection criteria and produce a GenPac within the desired range. We were unsuccessful in our attempts to use the EBA selection criteria to produce total NSN counts for these two GenPacs that were any closer to the plus or minus 10% range. Upon further review of these two GenPacs, we determined that neither exception significantly skewed the final results or recommendations for this project so we chose to report these two GenPacs at their initial NSN counts, which were both over the desired 10% range.

We tested all nine of the proposed CEC-focused GenPacs using the same simulated deployment requisitions method we used for the hits-focused proposed GenPacs; additionally, we again used the sustainment blocks carried by CLB 11 and CLB 15 as the basis of comparison. In Sections C and D of this chapter, we explain the details

of the model we built to test all 18 proposed GenPacs, along with the results of that model.

C. MODEL AND SIMULATION

For our project, we built a base spreadsheet model containing the requisition data pool, which we used to generate simulated deployment Class IX requisitions and a proposed GenPac. In our model, we used Oracle's Crystal Ball software to generate simulated requisition data in order to determine requisition fill rates. We replicated our model for all 18 proposed GenPacs that we built in this project. Oracle's Crystal Ball software is a spreadsheet-based application suite for predictive modeling, forecasting, simulation, and optimization. An example of the Crystal Ball output that our model produced can be seen in Figure 6.

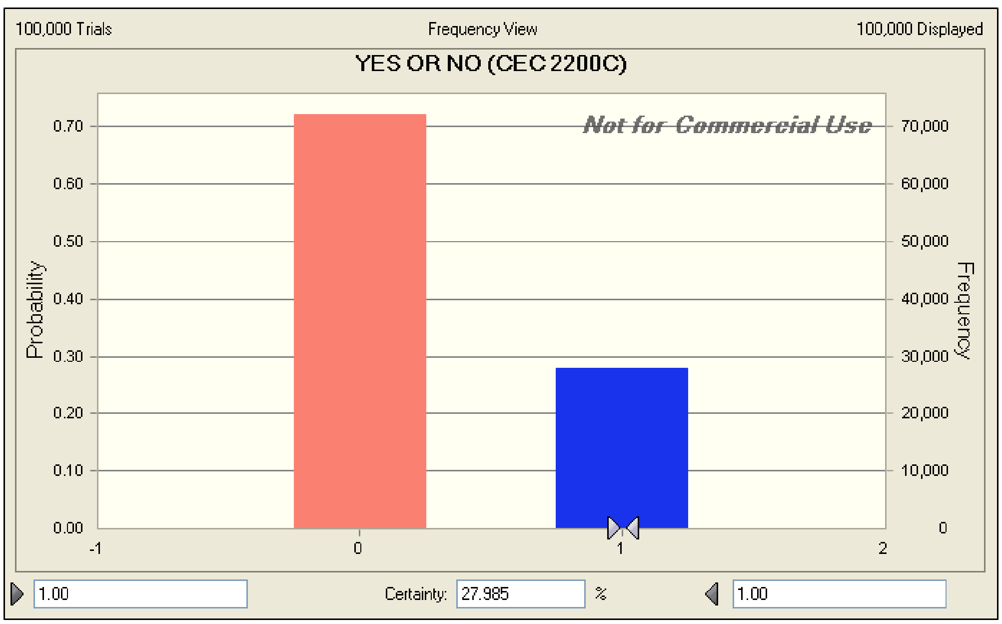

Figure 6. Crystal Ball Output Example

In the base model, we placed the requisition data pool on the left side of the spreadsheet and the proposed GenPac on the right side. The data pool included the nomenclature, NSN, hits, and demand columns for each NSN, as shown in Figure 7. Next, we created a simple numerical index column for the data pool starting at 1 and running to 1,491. Using the hits column, we summed all NSN hits to find the total

number of hits and created a percentage total for each NSN. Next, we created two Microsoft Excel *if*-statements that searched the proposed GenPac for each NSN resident in the data pool. If an NSN in the data pool was found in the proposed GenPac, then the *if*-statements would display a number 1 in the stocked-or-not column. A number 1 in the stocked-or-not column indicated that a requisition for that specific NSN could be filled immediately from a sustainment block built using that particular proposed GenPac.

Simulated MEU Deployment Using Crystal Ball

NOMENCLATURE	NSN	HITS	DEMAND	CEC	INDEX	% OF ALL HITS	STOCKED OR NOT		YES OR NO (CEC 1400C)	REQUISITION	BLOCK QTY	% OF DEMAND UNFILLED
WASHERS	0531-00-933-8118	1	1		1	0.027%	-	-	#N/A	0	FALSE	100%
DETENT,PAWL	1005-00-017-9540	1	1	5	2	0.027%	-	-			FALSE	100%
PIN,FIRING	1005-00-017-9547	2	25	5	3	0.054%	-	-			FALSE	100%
PIN,FIRING	1005-00-017-9547	3	25	5	4	0.081%	-	-			FALSE	100%
HAMMER,FIRING,SMALL	1005-00-017-9551	1	10	5	5	0.027%	-	-			FALSE	100%
ROD SECTION,CLEANIN	1005-00-050-6357	1	6	5	6	0.027%	-	-			FALSE	100%
RING,SLIP,HAND GUAR	1005-00-087-8998	1	30	5	7	0.027%	-	-			FALSE	100%
FIRING ATTACHMENT,B	1005-00-118-6192	1	4	5	8	0.027%	-	-			FALSE	100%
SPRING	1005-00-209-9691	3	4	0	9	0.081%	-	-			FALSE	100%
BRUSH,CLEANING,SMAL	1005-00-494-6602	2	20	5	10	0.054%	-	-			FALSE	100%
HELCOMPSPRING	1005-00-501-3516	2	15	0	11	0.054%	-	-			FALSE	100%
HELCOMPSPRING	1005-00-501-3527	2	1	0	12	0.054%	-	-			FALSE	100%
LATCH,BOLT	1005-00-550-4060	1	1	0	13	0.027%	-	-			FALSE	100%
SEAR	1005-00-550-4067	1	15	5	14	0.027%	-	-			FALSE	100%
EXTENSION ASSEMBLY,	1005-00-550-4082	27	15	5	15	0.729%	-	-			FALSE	100%
SLEEVE,BUFFER TUBE	1005-00-550-4094	2	1		16	0.054%	-	-			FALSE	100%
LEG,TRIPOD MOUNT	1005-00-556-4058	1	10	5	17	0.027%	-	-			FALSE	100%
ROD ASSEMBLY,OPERAT	1005-00-556-4305	3	1	5	18	0.081%	1,005,005,564,305	1			64	-6300%
HANDLE,BOLT	1005-00-600-8598	1	20	5	19	0.027%	-	-			FALSE	100%
PIN,FIRING	1005-00-600-8599	15	20	5	20	0.405%	-	-			FALSE	100%
PAWL,AMMUNITION FEE	1005-00-600-8918	12	15	5	21	0.324%	-	-			FALSE	100%
COVER,GUNSIGHT	1005-00-600-8935	8	15	2	22	0.216%	-	-			FALSE	100%
SPRING,SWITCH	1005-00-600-8949	10	15	0	23	0.270%	-	-			FALSE	100%
EXTRACTOR,CARTRIDGE	1005-00-600-8959	1	10	2	24	0.027%	-	-			FALSE	100%
PAWL,AMMUNITION FEE	1005-00-600-8961	1	1	5	25	0.027%	-	-			FALSE	100%
EXTENSION ASSEMBLY	1005-00-600-8976	1	15	5	26	0.027%	1,005,006,008,976	1			120	-700%
LEVER,BREECHBLOCK,C	1005-00-600-9718	1	15	5	27	0.027%	-	-			FALSE	100%
BRUSH,CLEANING,SMAL	1005-00-610-8828	2	4	5	28	0.054%	-	-			FALSE	100%
BOLT,SUB ASSEMBLY	1005-00-614-7463	1	1	5	29	0.027%	1,005,006,147,463	1			6	-500%

Figure 7. Data Pool of Simulated Requisitions

After we identified the data pool NSNs that were in the proposed GenPac, we used the index column and percent of all hits column, along with the custom distribution function in Crystal Ball, to define our Crystal Ball assumption. The Crystal Ball custom distribution assumption acted as a random number generator, which produced a numerical value ranging from 1 to 1,491. The number that the custom distribution produced then functioned as a reference to the index column and the specific NSN that was found at that index number. This custom distribution, working as a random number generator, represented a single theoretical MEU deployment supply requisition.

Lastly, we used Crystal Ball's forecasting feature to build a forecast that had an embedded Microsoft Excel lookup function in the yes-or-no column, as shown in Figure 7. This lookup function was designed to identify the random number generated from the Crystal Ball custom distribution in the requisition column, and then determine whether

that random index number had a 1 in its corresponding stocked-or-not cell. Each time we ran the custom distribution using the custom distribution and the Crystal Ball forecast, a single theoretical supply requisition was placed and either filled or not filled, based on whether the forecast found a 1 in the stocked-or-not column of that specific randomly generated index number. We set up the Crystal Ball forecast to execute 100,000 theoretical and individual random supply requisitions each time we ran the model. With such a high number of requisitions, we were able to determine a theoretical fill rate for that proposed GenPac.

We ran this model for each of the 18 proposed GenPacs we created in order to determine their theoretical fill rates. Then, using the exact method, as described in the previous paragraph, we determined fill rates for the sustainment blocks carried by CLB 11 and CLB 15 during their WestPac 09-2 and WestPac 10-1 deployments. For each of our 18 models containing different proposed GenPacs, we copied the model twice more and replaced the proposed GenPac on the right side of the model with the CLB 11 and CLB 15 sustainment blocks. Each of the 18 models contained five separate internal models: the first contained the specific proposed 1,000-NSN GenPac, the second contained the specific proposed 1,400-NSN GenPac, the third contained the CLB 11 sustainment block, the fourth contained the specific proposed 2,200-NSN GenPac, and the final model contained the CLB 15 sustainment block. By creating five internal models for each of the proposed GenPacs, we were able to run each of the respective models and determine a fill rate for the proposed GenPacs, the CLB 11 sustainment block, and the CLB 15 sustainment block using the same randomly generated supply requisition theory. This method allowed us to determine a fill rate for the different proposed GenPacs and comparative fill rates for sustainment blocks built under the current GenPac method.

D. DATA RESULTS

After running all the models for the hits-focused GenPacs, we were able to produce overall fill rates for all nine proposed GenPacs and both CLBs. All fill rates for

the proposed GenPacs and CLBs, along with total NSN, line-item counts, and a 99.5% confidence interval, are listed in Tables 5, 7, and 9.

After we ran the models, we created an additional feature within the model to identify the percentage of each requisition demand that was unfilled, as shown in Figure 7. To determine the percentage of each requisition demand that was unfilled, we identified both the simulated demand for that NSN and the quantity recommended within the proposed GenPac for that specific NSN. With both numbers identified, we simply subtracted the quantity being carried in the proposed GenPac from the simulated demand quantity and then divided the total by the simulated demand quantity. Once all percentages were determined, we added the percentages within each CEC and then took the average in order to determine an average percentage of unfulfilled demands for every CEC. All CEC line-item counts and the percent of demand unfilled for the proposed GenPacs and CLBs, along with a 99.5% confidence interval, are listed in Tables 6, 8, and 10.

Table 5. Hits-Focused Elimination-by-Aspects Results (Combined Data) With 99.5% Confidence Interval

	Total NSN	Total Line Items	Fill Rate	Confidence Interval	
				-	+
10% above CLB 15	2,139	17,837	29.128%	28.76%	29.50%
CLB 15	2,294	11,192	17.431%	17.12%	17.74%
10% above CLB 11	1,446	15,305	21.743%	21.41%	22.08%
CLB 11	1,455	9,037	18.298%	17.98%	18.61%
Under 1100	1,061	13,413	18.073%	17.76%	18.39%

Table 6. Hits-Focused GenPac (Combined Data) by CEC

	CEC 0	UF %	CEC 1	UF %	CEC 2	UF %	CEC 3	UF %	CEC 4	UF %	CEC 5	UF %	CEC 6	UF %	CEC 7	UF %	Missing CEC	UF %
10% above CLB 15	73	77%	2	100%	220	79%	27	77%	3	100%	1570	72%	48	73%	7	85%	189	78%
CLB 15	93	87%	21	89%	377	88%	26	85%	1	100%	1589	90%	77	91%	9	92%	101	87%
10% above CLB 11	42	83%	1	100%	134	82%	19	79%	2	100%	1073	78%	28	78%	5	100%	142	81%
CLB 11	36	92%	7	93%	179	87%	7	100%	3	100%	1133	89%	32	89%	6	100%	52	91%
Under 1100	30	86%	1	100%	88	85%	9	83%	2	100%	806	82%	22	81%	4	100%	99	84%

Table 7. Hits-Focused Elimination-by-Aspects Results (MEU Usage Data) With 99.5% Confidence Interval

	Total NSN	Total Line Items	Fill Rate	Confidence Interval	
				-	+
10% above CLB 15	2,139	17,837	29.128%	28.76%	29.50%
CLB 15	2,294	11,192	17.431%	17.12%	17.74%
10% above CLB 11	1,446	15,305	21.743%	21.41%	22.08%
CLB 11	1,455	9,037	18.298%	17.98%	18.61%
Under 1100	1,061	13,413	18.073%	17.76%	18.39%

Table 8. Hits-Focused GenPac (MEU Usage Data) by CEC

	CEC 0	UF %	CEC 1	UF %	CEC 2	UF %	CEC 3	UF %	CEC 4	UF %	CEC 5	UF %	CEC 6	UF %	CEC 7	UF %	Missing CEC	UF %
10% above CLB 15	75	78%	10	86%	309	80%	22	91%	3	100%	1591	75%	93	74%	13	92%	185	79%
CLB 15	93	87%	21	89%	377	88%	26	85%	1	100%	1589	90%	77	91%	9	92%	101	87%
10% above CLB 11	49	83%	1	100%	164	86%	17	100%	2	100%	1120	82%	57	81%	6	92%	101	84%
CLB 11	36	92%	7	93%	179	87%	7	100%	3	100%	1133	89%	32	89%	6	100%	52	91%
Under 1100	27	88%	1	100%	97	90%	13	100%	2	100%	798	88%	40	92%	3	92%	68	89%

Table 9. Hits-Focused Elimination-by-Aspects Results (Kinetic Data) With 99.5% Confidence Interval

	Total NSN	Total Line Items	Fill Rate	Confidence Interval	
				-	+
2200-2300	2,217	16,677	17.435%	17.13%	17.74%
CLB 15	2,294	11,192	17.431%	17.12%	17.74%
10% above CLB 11	1,447	13,341	15.519%	15.22%	15.81%
CLB 11	1,455	9,037	18.298%	17.98%	18.61%
Under 1100	1,053	12,432	14.252%	13.97%	14.54%

Table 10. Hits-Focused GenPac (Kinetic Data) by CEC

	CEC 0	UF %	CEC 1	UF %	CEC 2	UF %	CEC 3	UF %	CEC 4	UF %	CEC 5	UF %	CEC 6	UF %	CEC 7	UF %	Missing CEC	UF %
10% above CLB 15	118	94%	0	100%	217	84%	14	83%	3	100%	1388	87%	50	84%	6	100%	421	85%
CLB 15	93	87%	21	89%	377	88%	26	85%	1	100%	1589	90%	77	91%	9	92%	101	87%
10% above CLB 11	46	92%	0	100%	144	84%	15	85%	2	100%	1051	85%	14	84%	6	100%	169	86%
CLB 11	36	92%	7	93%	179	87%	7	100%	3	100%	1133	89%	32	89%	6	100%	52	91%
Under 1100	32	92%	0	100%	93	86%	12	85%	1	100%	777	86%	10	89%	4	100%	124	88%

After running all the models for the CEC-focused GenPacs, we were able to produce overall fill rates for all nine proposed GenPacs and both CLBs. Again, we

determined the percent of demand that was unfilled for all CECs within the proposed GenPacs in the same manner as we did for the hits-focused GenPacs. All fill rates for the proposed GenPacs and CLBs, along with total NSN and line-item counts, are listed in Tables 11, 12, and 13

Table 11. CEC-Focused Elimination-by-Aspects Results (Combined Data) With 99.5% Confidence Interval

	Total NSN	Fill Rate	Confidence Interval -	Confidence Interval +	Total CEC 5	UF % CEC 5	Total CEC 6	UF % CEC 6
10% above CLB 15	2,205	27.99%	27.62%	28.35%	2,136	68%	69	70%
CLB 15	2,294	17.43%	17.12%	17.74%	1589	90%	77	91%
10% above CLB 11	1,410	20.18%	19.85%	20.50%	1,375	76%	35	76%
CLB 11	1,455	18.30%	17.98%	18.61%	1133	89%	32	89%
Under 1100	1,100	18.75%	18.43%	19.07%	1,073	78%	28	78%

Table 12. CEC-Focused Elimination-by-Aspects Results (MEU Usage Data) With 99.5% Confidence Interval

	Total NSN	Fill Rate	Confidence Interval -	Confidence Interval +	Total CEC 5	UF % CEC 5	Total CEC 6	UF % CEC 6
10% above CLB 15	2,403	24.24%	23.89%	24.59%	2302	75%	101	80%
CLB 15	2,294	17.43%	17.12%	17.74%	1589	90%	77	91%
10% above CLB 11	1,681	20.80%	20.47%	21.13%	1,588	79%	93	82%
CLB 11	1,455	18.30%	17.98%	18.61%	1133	89%	32	89%
Under 1100	1,117	14.06%	13.77%	14.34%	1,120	84%	57	86%

Table 13. CEC-Focused Elimination-by-Aspects Results (Kinetic Data) With 99.5% Confidence Interval

	Total NSN	Fill Rate	Confidence Interval -	Confidence Interval +	Total CEC 5	UF % CEC 5	Total CEC 6	UF % CEC 6
10% above CLB 15	2,542	19.51%	19.18%	19.83%	2,439	80%	102	81%
CLB 15	2,294	17.43%	17.12%	17.74%	1589	90%	77	91%
10% above CLB 11	1,485	16.49%	16.19%	16.79%	1,463	81%	22	78%
CLB 11	1,455	18.30%	17.98%	18.61%	1133	89%	32	89%
Under 1100	1,065	13.21%	12.94%	13.49%	1,051	85%	14	84%

With all models completed and all fill rates established, we then found the confidence interval for all fill rates. A confidence interval is a specific kind of interval estimate of a population parameter and is used to indicate the reliability of an estimate. We picked a confidence interval percentage of 99.5% to ensure our fill rates were as accurate as possible. A confidence interval of 99.5% essentially means that there is a

99.5% chance that our selected fill rate will fall within the upper and lower limits. In the next paragraph, we demonstrate the confidence interval for the CEC-focused EBA sustainment block GenPac created to match the CLB 15 sustainment block. Figure 8 shows the mathematical equation for a confidence interval.

$$\hat{p} \pm z_{1-\alpha/2}\sqrt{\frac{\hat{p}\,(1-\hat{p})}{n}}$$

Figure 8. Confidence Interval Equation

Where $\hat{p}$ is the proportion of successes in our trial process estimated from the statistical sample, $z_{1-\alpha/2}$ is the $1 - \alpha/2$ quantile of a standard normal distribution, α is the error rate and n is the sample size. For this example, $\hat{p}$ is the fill rate of 27.985%, n is 100,000 for the number of replications, and the $z_{1-\alpha/2}$ is 2.576 when $\alpha = 0.01$. With all necessary numbers plugged into the equation in Figure 8, the lower and upper limits were 27.62% and 28.35%. The confidence interval results for all the GenPacs can be found in Tables 5–13.

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V. RESULTS

The current process for creating an MEU sustainment block is as follows:

1. The CLB creates the EDL.
2. The CLB forwards the EDL, including ID numbers, to the SMU.
3. The SMU identifies End Item Apps data.
4. Using MEF GABF and End Item Apps data, the SMU determines quantities for potential NSNs.
5. The SMU creates the GenPac and sends it to the CLB.
6. The CLB reviews the GenPac to determine actual NSNs and quantities of all NSNs included in the sustainment block.
7. The CLB submits the reviewed GenPac to the SMU to order the sustainment block.

In this project, we sought to take this process and formalize it after incorporating historical requisition data from all MEUs and using a multi-criteria decision-making process to increase the efficiency of the final sustainment block.

Increasing the efficiency and reducing the footprint of the MEU's sustainment block has a ripple effect throughout the entire ARG/MEU team. In today's strategic environment of reduced budgets and continuous operations, any improvement that allows the Marine Corps to operate at the same level while using fewer resources should be a welcome one. In this project, we demonstrated that, when it comes to the MEU sustainment block, this is possible. Using the multi-criteria decision-making process called elimination-by-aspects, pioneered by Amos Tversky (1972), we were able to construct sustainment blocks with a higher average fill rate compared to actual sustainment blocks used on deployments. This means that either a smaller block meets more requisitions at a lower cost to the Marine Corps, or sustainment blocks of equal size

with higher fill rates result in possibly lower shipping and transportation costs once deployed.

A. RESULTS

Using the EBA model to construct MEU sustainment blocks increases the average fill rate by 2.312%, even when the size threshold is set below 1,500 NSNs. When the threshold is kept the same as previous blocks, the average fill rate increases by 10.121%. This means that when a requisition is submitted to the CLB, the probability that the item is actually carried in the sustainment block will be higher. This translates to reduced costs through fewer back-order requisitions being passed to the SMU, necessitating requisitions being shipped via expedited manner from CONUS to the afloat MEU. Table 6 in Chapter IV demonstrates the exact fill rates achieved both from previous sustainment blocks constructed using the current method and from the sustainment blocks we constructed using the EBA model.

In addition to an increase in fill rate, blocks constructed through the use of the EBA model can be smaller. During this project, the target sustainment block size we used was 2,200 individual NSNs to match CLB 15's sustainment block; 1,400 individual NSNs to match CLB 11's sustainment block; and 1,000 individual NSNs for our proposed baseline. The average size of actual sustainment blocks taken on deployments that we used for comparison was 1,875 individual NSNs. This is a significant reduction in the materiel footprint and would allow for greater flexibility in storage, both before embarking on ARG ships and in the storage configuration once aboard.

A significant advantage of the EBA model is its ability to set a size threshold. As we discussed in Chapter IV, we set our proposed threshold to 1,000 NSNs and achieved increased fill rates. However, if the goal of an MEU is to maximize its potential fill rate while maintaining the current materiel footprint status quo, then the proposed threshold can be increased to produce the desired results. Increasing the materiel footprint threshold would allow for the inclusion of more NSNs and possibly provide a higher fill rate, as demonstrated by our model. Using the EBA model to construct sustainment

blocks opens the door for MEUs, and consequently CLBs, to determine their goals before ever drawing a single consumable Class IX item. The current method of sustainment block construction is an ad hoc process with few formal guidelines. This project lays the groundwork for a standardized process of designing and constructing a block with real, achievable goals.

B. RECOMMENDATIONS

1. During our research, we found no formal standard operating procedures (SOPs) in place for the GenPac creation process from HQMC or at any of the three SMUs. While formal SOPs are not the correct answer for every situation or problem, the GenPac creation process could benefit from a formal SOP. A formal SOP would allow for a standard baseline across all MEU GenPacs, which would help foster better communication between the SMUs and CLB supply staffs. We recommend that a formal and standardized method of constructing the MEU sustainment block be implemented. This formal and standardized method needs to be in writing, agreed upon, and shared between all three SMUs. The elimination-by-aspects model has shown its worth and its ease of use and should be central to that standardization. A formal method using standard tools can be taught at Marine Corps Combat Service Support School, benefiting every single supply officer and ensuring that each MEU can deploy with a more efficient and useful sustainment block.

2. During our research, we found it difficult to collect historical requisition data between the MEUs and to use all the data in a comparative manner due to the different pieces of requisition information each CLB reported. From the beginning, we were required to contact each CLB in order to identify the four AACs per MEU, as there is no central source able to access this information easily. The high turnover of personnel and constant deployments made this step difficult as we chased down out-of-office replies and bad phone numbers. Once all AACs were collected, the Birdtrack system was not able to provide accurate requisition information for all seven MEUs, and it could not access kinetic requisition data. We used the SASSY database to collect requisition information for all MEUs the Birdtrack system was not able to produce, but the SASSY

database also had difficulty collecting the kinetic requisition data. We are unclear as to how well the new Marine Corps supply and maintenance information system Global Combat Support System-Marine Corps (GCSS-MC) will improve data collection and data availability; this topic lends itself to further study.

We recommend that the retention of MEU requisition data be formalized across the Marine Corps. A standard format for reporting and archiving deployed MEU requisition data needs to be implemented at both the CLB and the SMU end of the requisition process. We believe this project has shown the potential benefits that would arise from CLB supply officers having easy access to historical and standardized sustainment block requisition data. Currently, such data are difficult to obtain and no formal guidelines exist, save from supply officer to supply officer.

3. We recommend that a central authority be made responsible for maintaining two-years' worth of MEU and kinetic requisition data that is accessible to all SMUs and CLBs. We recommend a central authority maintain the database to allow for proper control throughout personnel transition at using units and continuous updating of MEU requisition data. The updating process would need to ensure NSNs associated with old PEIs are removed as PEIs are phased out of use within the Marine Corps (e.g., the transition from the M198 artillery platform to the M777 platform required the removal of M198 Class IX consumable repair parts from MEU sustainment block GenPacs). Also, as the Marine Corps' support for OEF will eventually come to an end, the central authority will make the decision to remove OEF kinetic requisition data or to find a suitable alternative for kinetic requisition data to be included in the database. This collection of data would facilitate the GenPac creation process and allow for the EBA model to be used when CLBs review potential NSNs for inclusion in the GenPac.

4. Finally, we recommend that the designated central authority also maintain a web-based graphic user interface (GUI) that will allow CLB supply and maintenance staffs the ability to easily access the database described above. Figure 9 shows the example Microsoft Access GUI that was created and used in this project. The GUI will allow the user to simply select the criteria they would like included in a potential GenPac

listing. The GUI would also allow for rapid processing and comparison of numerous variations of different criteria settings, which provides for a better criteria selection process than the current take-everything-we-can-fit process.

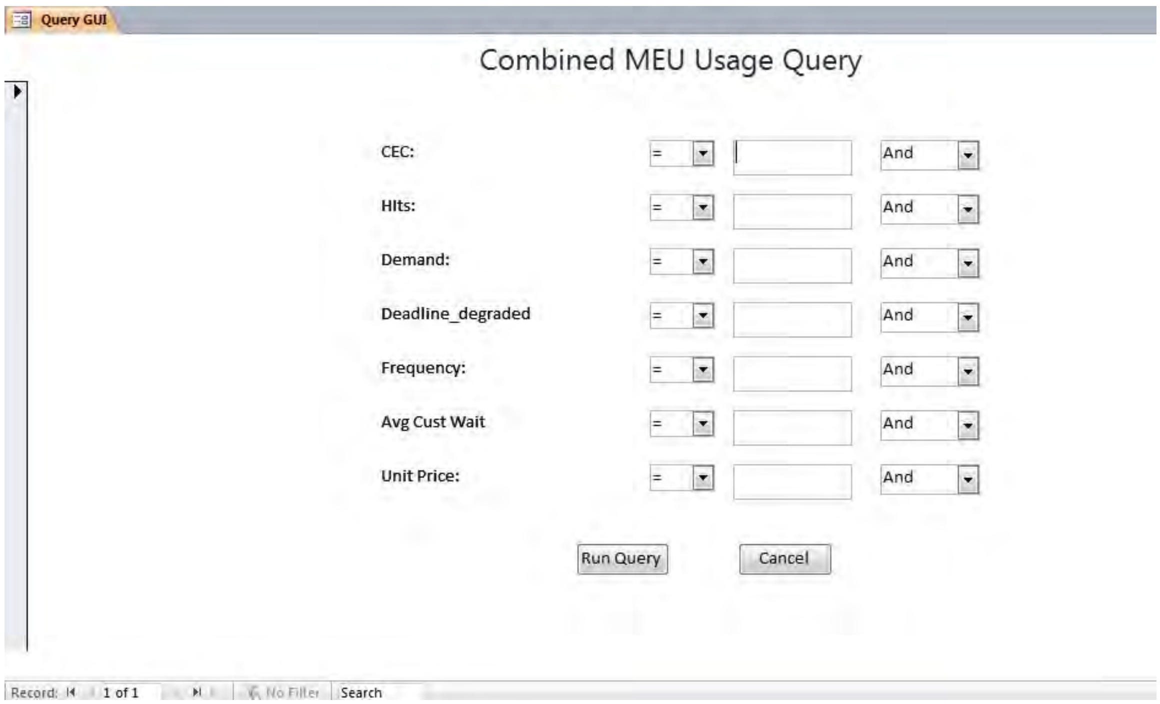

Figure 9. Proof of Concept of a Microsoft Access Query GUI

C. FURTHER STUDY

The Marine Corps would benefit a great deal from continuing to study how best to sustain expeditionary forces. The MEU sustainment block is just one facet of the entire expeditionary logistics picture. In this project, we have shown how it is possible to increase the efficiency of the MEU sustainment block while reducing cost and materiel footprint. We recommend that further study be conducted on the process once a requisition has been passed outside the MEU. Potential areas of study include the feasibility of increased forward staging of materiel, the benefit of utilizing existing logistics infrastructures and organizations overseas, and further integration with Navy supply inside the ARG.

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